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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/512,149	02/23/2000	Vishnu K Agarwal	MI22-1322	3457

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EXAMINER

PIZARRO CRESPO, MARCOS D

ART UNIT	PAPER NUMBER
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2814

DATE MAILED: 09/24/2002

26

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/512,149

Applicant(s)

AGARWAL, VISHNU K

Examiner

Marcos D. Pizarro-Crespo

Art Unit

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 08 August 2002.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1,4-16 and 56-72 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1,4-16 and 56-72 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 22,24. 6) ☐ Other: _____

Attorney's Docket Number: MI22-1322

Filing Date: 2/23/2000

Claimed Foreign Priority Date: none

Applicant(s): Agarwal

Examiner: Marcos D. Pizarro-Crespo

DETAILED ACTION

This Office action responds to the amendment (paper no. 25) filed on 8/8/2002.

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after a final rejection. Since this application is eligible for a continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action (paper no. 21) has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 7/25/2001 has been entered.

Acknowledgment

2. The amendment (paper no. 25) filed on 8/8/2002 in response to the Office action (paper no. 21) mailed on 5/8/2002 has been entered. The present Office action (paper no. 26) is made with all the suggested amendments being fully considered. Accordingly, pending in this office action are claims 1, 4-16, and 56-72.

Claim Rejections - 35 USC § 112

3. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

4. Claims 69 and 70 are rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

5. Lines 1-3 of each of claims 69 and 70 recite the limitation "the high-K dielectric layer has at least a portion comprising less than or equal to 98% crystalline material". The description in the original disclosure fails to support this limitation in the claims. The specification (pp.7/II.16-17) discloses the high-K dielectric layer having a crystalline portion that is 70% crystalline or greater. The open-ended numerical range in claims 69 and 70 specifying that a portion of the dielectric layer is 98% crystalline or lower did not meet the description requirement because the phrase "less than" had no lower limit causing the claims to literally read on embodiments outside the disclosed range.

6. The following is a quotation of the fourth paragraph of 35 U.S.C. 112:

Subject to the following paragraph, a claim in dependent form shall contain a reference to a claim previously set forth and then specify a further limitation of the subject matter claimed. A claim in dependent form shall be construed to incorporate by reference all the limitations of the claim to which it refers.

7. Claim 10 is rejected under 35 U.S.C. 112, fourth paragraph, as being improper dependent claims for failing to include every limitation of a claim from which they depend.

8. The limitations in claim 10 infringe the limitations in basic claim 1. Whereas claim 1 recites that the crystalline-material layer is less than 98% crystalline, claim 10 recites that the crystalline-material layer is at least 98% crystalline. The open-ended

numerical range in claim 10 includes a 100%-crystalline layer in its recited range. Claim 1, on the other hand, excludes a 100%-crystalline layer from its recited range.

Claim Rejections - 35 USC § 102

9. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

10. Claims 63, 71, and 72 are rejected under 35 U.S.C. 102(b) as being anticipated by Deboer (US 5930106).

11. Deboer shows (see, e.g., fig. 4) most aspects of the instant invention including an integrated circuitry comprising:

- a substrate **10**
- an insulative material **15** over the substrate **10**
- an opening formed in the insulative material **15** (see, e.g., fig. 1)
- a capacitor comprising:
 - a first electrode layer **21** formed within the opening
 - a high-K dielectric layer **31** formed over the first electrode layer **21** and within the opening
 - a second electrode layer **41** formed over the high-K dielectric layer **31**

12. Regarding claim 71, Deboer shows the opening comprising a trench (see, e.g., fig. 1).

13. Regarding claim 72, Deboer shows the second electrode layer **41** formed within the opening (see, e.g., fig. 4).

Claim Rejections - 35 USC § 103

14. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

15. Claims 1, 4-11, 13-15, and 56 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ramakrishnan (US 5192871).

16. Ramakrishnan shows (see, e.g., fig. 2) all aspects of the instant invention including an integrated circuitry comprising a capacitor comprising:

- a first capacitor electrode **14**
- a second capacitor electrode **20**
- a high-K capacitor-dielectric region between the capacitor electrodes comprising:
 - a high-K substantially-amorphous-material layer **18**
 - a high-K substantially-crystalline-material layer **16** over the amorphous-material layer **18**

Ramakrishnan also shows that the crystalline-material layer and the amorphous-material layer may be made out of different chemical compositions (col.2/ll.46-50), and that the crystalline-material layer should be formed in a crystalline form (col.2/ll.38-40).

Ramakrishnan, however, fails to disclose that the crystalline-material layer is 70-98% crystalline. Although Ramakrishnan does not teach the specific range claimed by

the applicants, he discloses (col.2/ll.34-57) that the crystalline dielectric material should be 100% crystalline. The claimed crystallinity range is closed enough to the crystallinity of Ramakrishnan's dielectric layer that one of ordinary skill in the art would have expected both layers, *i.e.*, the claimed layer and Ramakrishnan's layer, to have the same properties (*Titanium Metal Corp. of America v. Banner*, 778 F.2d 775, 227 USPQ 773, Fed. Cir. 1985).

In fact, the applicants support this statement in their specification. See, for example, pp.7/ll.16-21 of the specification, where the applicants clearly teach that a crystalline-material layer more than 98% crystalline, a crystalline-material layer more than 90% crystalline, or even a crystalline-material layer that is more than 70% crystalline, should all be regarded as "substantially crystalline".

Consequently, it would have been obvious to one of ordinary skill in the art at the time of the invention to have Ramakrishnan's crystalline-material layer having between 70-98% crystallinity since this crystallinity range is close enough to the crystallinity of Ramakrishnan's layer and it has been held that a *prima facie* case of obviousness exists where the claimed and prior-art ranges do not overlap but are close enough that one skilled in the art would have expected them to have the same properties.

17. Regarding claim 4, Ramakrishnan shows at least one of the first and second electrodes comprising a metal (col.1/ll.60).

18. Regarding claims 5-9, 11, 13-15, Ramakrishnan's shows (see, *e.g.*, fig. 2):

- the capacitor over a semiconductor substrate **12**
- the dielectric layer received between the first and second capacitor plates **14 20**

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- the amorphous layer **18** contacting the first capacitor electrode **14**
- the crystalline layer **16** contacting the second capacitor electrode **20**
- the dielectric layer as the only capacitor dielectric region between the capacitor electrodes **14 20**
- the amorphous material layer **18** received between the semiconductor substrate **12** and the crystalline dielectric layer **16**

19. Regarding claims 10 and 56, Ramakrishnan discloses (col.2/ll.34-57) the amorphous dielectric material as completely amorphous (100% amorphous) so as to prevent penetration of conductive foreign materials into the film, whereas the crystalline dielectric material should be completely crystalline (100% crystalline) so as to have the highest possible dielectric layer.

20. Claims 12 and 16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ramakrishnan, as applied to claim 1 above, and further in view of Graettinger (US 5844771).

21. Ramakrishnan shows most aspects of the instant invention but a capacitor wherein the semiconductor substrate comprises bulk monocrystalline silicon (see paragraphs 4-7 above). Graettinger teaches that in the processing of integrated circuits the substrate typically comprises monocrystalline silicon (col.1/ll.20-24).

It would have been obvious at the time of the invention to one of ordinary skill in the art to have the substrate of Ramakrishnan comprising monocrystalline silicon, as suggested by Graettinger, because in the processing of integrated circuits the substrate is typically monocrystalline silicon.

22. Claims 57-59 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ramakrishnan in view of Narui (US 6201728) and Merchant (US 6235594).

23. Ramakrishnan shows most aspects of the instant invention (see paragraphs 17-20 above), except for an insulative layer between the substrate and the capacitor electrodes. Narui, on the other hand, teaches that an insulating layer formed between the substrate and the capacitor insulates the electrodes thereof and hence the leakage current is minimized. Merchant further teaches that this insulation layer is typically silicon dioxide.

Accordingly, it would have been obvious at the time of the invention to one of ordinary skill in the art at the time of the instant invention to include a silicon-dioxide insulative film between Ramakrishnan substrate and his capacitor, as suggested by Narui and Merchan, to minimize the leakage current.

24. Claims 60-62 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ramakrishnan in view of Eguchi (US 5442585) and Shrivastava (US 5557122).

25. Ramakrishnan shows most aspects of the instant invention (see paragraphs 17-20 above), except for the specific capacitor-dielectric thickness claimed by the applicants *i.e.*, an amorphous dielectric thickness of 20-250Å, a crystalline dielectric thickness of 20-90Å, and a capacitor-dielectric region of 40-500Å.

Ramakrishnan, however, shows that the crystalline-dielectric layer may have a thickness of 100Å (col.3/ll.44) and that the amorphous-dielectric layer should be as thin as possible in order to prevent degradation of the capacitor performance (col.4/ll.20-26). Although Ramakrishnan does not specify the same dielectric thickness as those

claimed by the applicants, thickness differences are considered obvious design choices and are not patentable unless unobvious or unexpected results are obtained from these changes.

Shrivastava, for example, teaches that the capacitor-dielectric thickness is a design variable that if reduced will increase the capacitance of the capacitor (col.2/ll.59-63). Likewise, Eguchi teaches that in order to increase the capacitance of a capacitor, the thickness of the capacitor dielectric should be reduced; however, if the film is made too thin, the performance of the capacitor deteriorates (col.1/ll.44-48).

Accordingly, it would be an obvious matter of design choice to select a suitable thickness for the capacitor-dielectric layers of Ramakrishnan, as taught by Shrivastava and Eguchi, since the capacitor-dielectric thickness is variable of importance subject to routine experimentation and optimization and it is not inventive to discover the optimum or workable ranges by routine experimentation. *In re Aller*, 220 F.2d 454, 105 USPQ 233, 235. Furthermore, it appears that the dielectric-thickness differences between Ramakrishnan and the claimed invention produce no functional differences and therefore would have been obvious. Note *In re Leshin*, 125 USPQ 416.

26. Claims 64-68 are rejected under 35 U.S.C. 103(a) as being unpatentable over Deboer (US 5930106) in view of Anderson (US 5390072).

27. Regarding claims 64-66, Deboer shows most aspects of the instant invention (see paragraphs 12-14 above), except for the high-K dielectric layer having at least a portion comprising crystalline material and at least a portion comprising amorphous material.

Anderson (col.4/ll.33-39), on the other hand, teaches that when an amorphous layer of a dielectric is formed on a polycrystalline layer of the same dielectric a synergism occurs which provides more efficient high capacitance-performance than otherwise considered achievable through the use of a particular dielectric.

It would have been obvious at the time of the invention to one of ordinary skill in the art at the time of the invention to have Deboer's dielectric layer comprising a portion of amorphous material and a portion of crystalline material, as suggested by Anderson, to provide a more efficient high capacitance-performance of the capacitor.

28. Regarding claim 67, Deboer shows most aspects of the instant invention (see paragraphs 12-14 above), except for the high-K dielectric layer having at least a portion comprising crystalline material and at least a portion comprising amorphous material.

Anderson (col.4/ll.33-39), on the other hand, teaches that when an amorphous layer of a dielectric is formed on a polycrystalline layer of the same dielectric a synergism occurs which provides more efficient high capacitance-performance than otherwise considered achievable through the use of a particular dielectric. According to Anderson, one of the embodiments, see, e.g., fig. 2, has the amorphous layer adjacent to the first electrode layer and the crystalline layer adjacent to the second electrode layer.

It would have been obvious at the time of the invention to one of ordinary skill in the art at the time of the invention to have Deboer's dielectric layer comprising an amorphous layer adjacent to the first electrode and a crystalline layer adjacent to the

second electrode, as suggested by Anderson, to provide a more efficient high capacitance-performance of the capacitor.

29. Regarding claim 67, Deboer shows most aspects of the instant invention (see paragraphs 12-14 above), except for the high-K dielectric layer comprising a crystalline layer adjacent to the first electrode layer and an amorphous layer adjacent to the second electrode layer.

Anderson (col.4/ll.33-39), on the other hand, teaches that when an amorphous layer of a dielectric is formed on a polycrystalline layer of the same dielectric a synergism occurs which provides more efficient high capacitance-performance than otherwise considered achievable through the use of a particular dielectric. According to Anderson, one of the embodiments, see, e.g., fig. 2, has the crystalline layer adjacent to the first electrode layer and the amorphous layer adjacent to the second electrode layer.

It would have been obvious at the time of the invention to one of ordinary skill in the art at the time of the invention to have Deboer's dielectric layer comprising a crystalline layer adjacent to the first electrode and an amorphous layer adjacent to the second electrode layer, as suggested by Anderson, to provide a more efficient high capacitance-performance of the capacitor.

Response to Arguments

30. The applicant argues:

Claim 1 recites that a high-K substantially crystalline material is at least 70% crystalline and less than 98% crystalline. Ramakrishnan teaches an insulative layer 16 that is crystalline in form and fails to disclose or suggest the claimed percentages. Accordingly, Ramakrishnan does not teach or suggest a high-K substantially crystalline material layer that is at least 70% crystalline and less than 98% crystalline as it is recited in claim 1.

The examiner responds:

Although Ramakrishnan does not teach the specific range claimed by the applicants, he discloses (col.2/ll.34-57) that the crystalline dielectric material should be 100% crystalline. The claimed crystallinity range, *i.e.*, 70-98% crystalline, is closed enough to the crystallinity of Ramakrishnan's dielectric layer, *i.e.*, 100% crystalline, that one of ordinary skill in the art would have expected both layers to have the same properties (*Titanium Metal Corp. of America v. Banner*, 778 F.2d 775, 227 USPQ 773, Fed. Cir. 1985).

In fact, the applicants support this statement in their specification. See, for example, pp.7/ll.16-21 of the specification, where the applicants clearly teach that a crystalline-material layer more than 98% crystalline, *i.e.*, 98-100% crystalline, a crystalline-material layer more than 90% crystalline, *i.e.*, 90-100% crystalline, or even a crystalline-material layer that is more than 70% crystalline, *i.e.*, 70-100% crystalline, should all be regarded as "substantially crystalline".

Consequently, it would have been obvious to one of ordinary skill in the art at the time of the invention to have Ramakrishnan's crystalline-material layer having 70-98% crystallinity since this crystallinity range is close enough to the crystallinity of Ramakrishnan's layer, *i.e.*, 100%-crystalline, and it has been held that a *prima facie* case of obviousness exists where the claimed and prior-art ranges do not overlap but are close enough that one skilled in the art would have expected them to have the same properties.

31. Applicant's arguments with respect to claims 57-59 have been considered but are moot in view of the new ground(s) of rejection.

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32. The applicant argues:

Ramakrishnan fails to teach the specific thicknesses for the amorphous material layer, crystalline material layer and capacitor dielectric film. The examiner attempts to correct the deficiency by alleging such teaching would be an obvious design choice based on the teachings of Shrivastava and Eguchi because a layer thickness is a variable of importance subject to routine experimentation for the optimal or workable ranges. The examiner further cites *In re Aller*, 220 F.2d 454, 105 USPQ 233, 235 (CCPA 1955).

This is contrary to the interpretation of *Aller* presented by the MPEP where only concentration or temperatures are relevant physical characteristics to the routine experimentations for the optimal or workable ranges determination. In other words, the MPEP fails to state that a physical characteristic, such as thickness, may be optimized. Consequently, the combination of Ramakrishnan, Shrivastava, and Eguchi is improper.

The examiner responds:

The fact that the MPEP fails to explicitly disclose that some physical characteristics, such as thickness, may be optimize, does not oppose the fact that such characteristics may be optimized.

According to the MPEP § 2144.05.II.B "A particular parameter must first be recognized as a result-effective variable, *i.e.*, a variable which achieves a recognized result, before the determination might be characterized as routine experimentation. *In re Antonie*, 559 F.2d 618, 195 USPQ 6 (CCPA 1977); *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980)". Shrivastava (col.2/ll.59-63) and Eguchi (col.1/ll.44-48) clearly comply with the guidelines in the MPEP as both references teach that a capacitor-dielectric thickness is a design variable of importance subject to routine experimentation and optimization.

According to *In re Aller*, 220 F.2d 454, 456, 105 USPQ 233, 235 (CCPA 1955): "[W]here the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation". Along these lines, Ramakrishnan shows most aspects of the instant invention (see paragraphs 17-20 above), except for the specific capacitor-dielectric thickness claimed

by the applicants *i.e.*, an amorphous dielectric thickness of 20-250Å, a crystalline dielectric thickness of 20-90Å, and a capacitor-dielectric region of 40-500Å.

Ramakrishnan, however, shows that the crystalline-dielectric layer may have a thickness of 100Å (col.3/II.44) and that the amorphous-dielectric layer should be as thin as possible in order to prevent degradation of the capacitor performance (col.4/II.20-26). Although Ramakrishnan does not specify the same dielectric thickness as those claimed by the applicants, thickness differences are considered obvious design choices, as taught by Shrivastava and Eguchi, and are not patentable unless unobvious or unexpected results are obtained from these changes.

Comments

33. Applicant is advised that should claims 11 and 12 be found allowable, claims 15 and 16 will be objected to under 37 CFR 1.75 as being a substantial duplicate thereof. When two claims in an application are duplicates or else are so close in content that they both cover the same thing, despite a slight difference in wording, it is proper after allowing one claim to object to the other as being a substantial duplicate of the allowed claim. See MPEP § 706.03(k).

Conclusion

34. Papers related to this application may be submitted directly to Art Unit 2814 by facsimile transmission. Papers should be faxed to Art Unit 2814 via the Art Unit 2814 Fax Center located in Crystal Plaza 4, room 3C23. The faxing of such papers must conform to the notice published in the Official Gazette, 1096 OG 30 (15 November

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1989). The Art Unit 2814 Fax Center number is **(703) 308-7722** or **-7724**. The Art Unit 2814 Fax Center is to be used only for papers related to Art Unit 2814 applications.

35. Any inquiry concerning this communication or earlier communications from the examiner should be directed to **Marcos D. Pizarro-Crespo** at **(703) 308-6558** and between the hours of 9:00 AM to 7:30 PM (Eastern Standard Time) Monday through Thursday or by e-mail via Marcos.Pizarro@uspto.gov. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri, can be reached on (703) 306-2794.

36. Any inquiry of a general nature or relating to the status of this application should be directed to the **Group 2800 Receptionist** at **(703) 308-0956**.

37. The following list is the Examiner's field of search for the present Office Action:

Field of Search	Date
U.S. Class / Subclass(es): 257/310, 438/240, 361/313	9/9/2002
Other Documentation:	
Electronic Database(s): EAST (USPAT, EPO, JPO)	9/9/2002



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